

Annual Review of Food Science and Technology
Addressing Consumer Desires
for Sustainable Food Systems:
Contentions and Compromises

Craig Upright

Department of Sociology, Winona State University, Winona, Minnesota, USA;
email: cupright@winona.edu

ANNUAL
REVIEWS **CONNECT**

www.annualreviews.org

- Download figures
- Navigate cited references
- Keyword search
- Explore related articles
- Share via email or social media

Annu. Rev. Food Sci. Technol. 2023. 14:411–25

First published as a Review in Advance on
January 9, 2023

The *Annual Review of Food Science and Technology* is
online at food.annualreviews.org

<https://doi.org/10.1146/annurev-food-060721-022439>

Copyright © 2023 by the author(s). This work is licensed under a Creative Commons Attribution 4.0 International License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited. See credit lines of images or other third-party material in this article for license information.



Keywords

sustainable food systems, organic food, fair trade, collective behavior

Abstract

Consumers and social movement activists have been the driving force to create alternative, sustainable food systems over the past 100 years. Although larger agribusiness market players and the state were at first reluctant to respond to these concerns, as organic food products (the most prominent example of alternative food) became a viable economic market, these market players embraced them. The international trade of organic food has developed into a major agricultural and retail sector, but with this growth many of the varied original critiques of conventional, industrial farming practices have yet to be adequately addressed. Every major advancement in sustainable agriculture has raised new issues of equity and access for producers, laborers, and consumers. Although consumers often believe that they are contributing to a project of larger social change with every market transaction they make, the continued success of the organic food system has spurred calls for more explicit forms of collective behavior to promote the larger goals of the original sustainable agriculture movements.

Organic agriculture: regulated practices involving methods (e.g., crop rotation) or inputs (e.g., green manure) as an alternative to those relying on petrochemicals

Locavores: individual consumers who explicitly organize their nutritional lives to consume local foods, deliberately supporting local foodsheds

Foodsheds: based on the concept of a watershed; a geographic region with producers and other social actors that provides the food to sustain itself

Alternative food systems: food chain regimes associated with reforming social arrangements related to production, distribution, retailing, and consumption to emphasize equity for all social actors

INTRODUCTION

Over the past half-century, a new sector has risen within the national and global agricultural market related to sustainable food products. This sector was motivated largely by consumer demand, stemming from concerns that the increasingly industrialized food market was causing damage to the health of individuals, local food-provisioning regimes, and natural environments. Although these issues predated the counter-cultural social movements of the late 1960s, the organizational infrastructure to facilitate the production, distribution, marketing, and retailing of these food products began in earnest during the cultural and political climate that gave rise to the first Earth Day celebration in 1970.

This review is not focused on the science underlying organic agriculture or sustainable food systems. Most consumers are attracted to this sector based on the ideological and cultural values associated with this product; the primary challenges in the early years of this industry involved establishing trust at each transaction nexus, including regulatory labeling. This review is focused on studies conducted over the past 20 years that examine the relationships—formal and informal—that have developed among social actors in this market. Although most of the works cited in this review are peer-reviewed articles appearing in academic journals, some are longer-length research monographs intended for both scholars and sophisticated general audiences. Given the increasing public interest in these topics—one possible marker of success for sustainable food movements—there is a wealth of mass-media articles intended for the general public. The author has refrained from referencing such articles, despite their relevance and often well-sourced content.

As emerging (and sometimes competing) alternatives to mainstream provisioning regimes are promoted in political, popular, regulatory, and scientific realms, many social actors use (or create) different terms to describe these agricultural systems and the foods they produce. A variety of consumer-focused food movements have arisen throughout the past several decades. The “slow-food” movement, for example, arose as an oppositional lifestyle that rejected “fast food” culture, emphasizing a more deliberate approach to planning and enjoying meals (Pietrykowski 2004, Willk 2006). Similarly, the rise of the “locavore” as an identity group speaks to an increasing desire among consumers to create stronger connections to local systems of food provisioning (Adams 2018, DeLind 2011, Gray 2014b, Nabhan 2009, Pollan 2006). Peters et al. (2009) provide an excellent analysis of “local foodsheds” and their potential to help address larger issues of agricultural sustainability. Rachel Shindelar (2015) addresses the benefits of local sourcing as a form of sustainable food systems, despite concerns that reduced greenhouse emissions from shorter transportation costs might be overstated; the first issue of the Rachel Carson Center *RCC Perspectives* provides an excellent primer for these issues. The rise of community-supported agriculture has also emerged as an institutional response to these concerns (Brown & Miller 2008, Cone & Myhre 2000, Holcomb et al. 2018).

Individuals have always crafted personal diets that restrict or remove the intake of particular food products (vegetarianism, veganism) or specific ingredients (such as gluten-, lactose-, or sodium-free diets). None of these projects or personal proclivities, however, has given rise to a particular agricultural or economic sector beyond spurring the support of individual purveyors that might cater to such preferences. All these dietary/purchasing/consumption regimes are pursued as alternative food systems, explicitly attempting to change (if not outright reject) what is often termed conventional, mainstream, or perhaps corporate agribusiness market arrangements.

Instead of categorizing food movements based on what some individuals reject, it is often more useful to focus on what they attempt to promote with their conscious consumption habits. The concept of sustainable foods is both much broader and more reliant on a variety of organizational actors to create a viable market infrastructure (for a useful overview of the various concepts and

definitions in this area often referred to as ethical trade, see Browne et al. 2000). The most visible category in this sector is organic food, although more recent variations on the initial consumer concerns have focused on fair-trade products—those that support humane working conditions and sustainable local economies. Well beyond the somewhat nebulous appellation of “natural” foods—a term that the US Food and Drug Administration has had difficulty in regulating (Hooker et al. 2018) and raised concerns about within the Federal Trade Commission with regard to unverifiable claims—the label of “organic” quickly emerged during the 1960s and 1970s as a hotly contested term that incorporated scientific specification with practical production methods while surrounded by cultural/political understandings among a growing consuming public.

HISTORICAL OVERVIEWS OF SUSTAINABLE FOOD PROJECTS

Although production regimes surrounding organic food might have received the most mainstream attention, these are just one aspect of the sector referred to as the sustainable agricultural market. This review makes such distinctions when necessary.

Sustainable agriculture is generally referred to as an alternative food system, an oppositional term that encompasses a variety of critiques to the current set of industrialized, technology-focused practices generally referred to as “conventional” agriculture (Goodman & Redclift 1991, Goodman & Watts 1997). Several popular documentary films have helped introduce these issues to larger mainstream audiences, such as *Food Inc.*, *Food Matters*, *Ingredients*, *King Corn*, and *Supersize Me*.

But just as the critiques leveled at conventional agriculture are wide and varied, the proposed alternatives also take very different approaches (Goodman et al. 2014). Plumecocq et al. (2018) provide an interesting typology of such alternative food systems based on larger principles: “These conceptual dichotomies oppose two kinds of agroecological practices (i.e., two kinds of relationships to nature): one that considers technological progress as the way to address environmental issues, and another that targets better protection or restoration of natural capital to increase ecosystem services.” [For further illustrations of the many competing goals and programs found within alternative food systems, see the March 2016 special issue of *Ecology and Society* devoted to “multicriteria assessment of food system sustainability” (Alrøe et al 2016)].

Early twentieth-century activists attempted to address social problems affecting three primary realms. For individuals, organic (or natural) foods could be perceived as healthier because they involved fewer additives—during production or processing—and were much less likely to contain harmful chemical residues (Rodale 1967). Organic production techniques could also improve the health of the land; this might help restore some harmony in nature (Steiner 1993). With a motto of “feed the soil, not the plant,” the orientation involved ensuring that future crops could be grown in perpetuity without requiring ever more input substitutions that treated farms as factories (Fitzgerald 2003). Finally, increased attention to the entire food distribution system—from initial production to final consumption, including how waste by-products are dealt with at every step—would help focus attention on the more local individuals and organizations that promote sustainable economies (Howard 1940).

In these earlier historical periods, of course, the shared understanding of what organic actually meant was still a work in progress. Several research monographs have described the rise of the organic food movement, describing the activities of individual activists, social movement organizations, market actors, and the state. These have been intended for both general and academic audiences. The organic food movement began in earnest during the early- and mid-twentieth century. In the United States, J.I. Rodale is largely credited with articulating the principles of organic agriculture for both rural farmers and urban gardeners in the 1940s, when he began publishing

Ethical trade: market systems privileging labor rights and working conditions, seeking to reduce exploitation by wealthier consumers of workers in poorer economies

Sustainable agriculture: production methods promoting the preservation of resources to provide future generations with the ability to produce the food required by society

Organic foods:

products adhering to post-1970 regulatory production standards emphasizing reduced use of petrochemicals and other practices that maintain the viability of natural resources

the periodical *Organic Gardening and Farming*. Rodale Publishing continued to promote health, wellness, and environmental awareness [including the magazines *Prevention* and *Runner's World* and Al Gore's (2006) *An Inconvenient Truth*] until it was acquired by Hearst Communications in 2017.

Although many authors, theorists, and scientists had begun to outline their concerns with industrialized agriculture, Rachel Carson's (1962) *Silent Spring* cogently illustrated the environmental consequences of poorly regulated chemical use. Other books on pesticide abuse followed: Robert Rudd's (1964) *Pesticides and the Living Landscape*; Frank Graham's (1970) *Since Silent Spring*; and Robert van den Bosch's (1978) *The Pesticide Conspiracy*.

The strong social movements that promoted alternative agricultural systems—organic, biodynamic, natural—prompted many studies of collective behavior. Jeffrey Haydu (2011), for example, explored the similarities and differences between the 1960s organic activists with those of the 1830s Grahmites, finding that the more contemporary groups have framed their work in light of environmentalism and New Left democratic ideals.

Philip Conford's (2001) *The Origins of the Organic Movement* focuses on the conservative conservationist activists challenging the threats to the previously bucolic country environments between the 1920s and 1960s. This work demonstrates that a variety of separate critiques, primarily in Britain and America, began to coalesce into the movement contemporary readers are more familiar with. Stemming from concerns arising from a common source—the industrial logic of capitalist agriculture that sought to routinize, mechanize, and stabilize the processes for commodity food production—these earlier social movement actors coupled their critiques with a promotion of spiritual, political, and occasionally fascist ideologies. Gregory Barton's (2018) *The Global History of Organic Farming* presents a different take on this history, expanding the geographic areas of interest and continuing the story into and beyond the 1980s.

A third major overview work in this area is Samuel Fromartz's (2006) *Organic, Inc.: Natural Foods and How They Grew*, which approaches the subject from the author's perspective as a journalist focusing on business issues. As such, this work addresses the late-twentieth-century attempts by larger agribusiness concerns to take advantage of the ever-increasing consumer demand for organic, natural, and sustainable foods. As Fromartz points out, in the first years of this century some of the largest food corporations such as Kraft and General Mills controlled the majority of the organic market; half of all organic sales of domestic products came from only 2% of the largest farms in the United States.

A final overview is Michael Haedicke's (2017) more academically oriented research monograph *Organizing Organic: Conflict and Compromise in an Emerging Market*. In this work, Haedicke addresses the central paradox created by the increasing popularization and mainstreaming of organic foods in the public market: The ideological underpinnings that gave rise to organic food in the first place had a marked anticorporatist orientation, but satisfying the ever-growing demand for organic food was most readily addressed by the largest corporations that also benefit from the most decried industrialized agricultural methods. As indicated in its subtitle, the continued development of this sector involves conflict and compromise from all parties (including consumers). Written from the perspective of an organizational sociologist, this work is perhaps the best suited for understanding the negotiated social meanings of the constructed economic transactions that take place throughout the entire sustainable food market.

The remainder of this review focuses on specific nexuses in which both the meaning of these alternative food products is (re)created and the economic transactions take place: producers, retailers, and consumers. It ends with a discussion of state regulation and the global nature of these markets.

PRODUCERS, WORKERS, AND RETAILERS

Analyses of organic producers generally focus on two different phenomena. The first involves large agri-corporations seeking to gain a stronger foothold within the sustainable food market. As consumer demand for organic food products grew in the 1980s, and especially following the passage of the Organic Foods and Production Act of 1990, many large industrial producers sought to influence the specific regulations that must be followed. As Buck et al. (1997, p. 4) wrote, “agribusiness is finding ways to industrialize organic production.” These concerns have continued following the creation of the standards, as previously “nonorganic” agricultural players have sought to be associated with and part of standards-based alternative food markets (Jaffee 2010).

This larger phenomenon largely contradicts the more bucolic farming scenes presented on the labels of many contemporary organic products. Julie Guthman’s (2004) *Agrarian Dreams: The Paradox of Organic Farming in California* provides an excellent account of the evolution of organic farming in California. It is more expensive to operate an organic farm (contributing to the higher cost for consumers), including the costs associated with certification; there are logical benefits to scaling up operations. The central paradox explored by Guthman is one that shapes many contemporary critiques: As the consumer demand for organic products grew, the producers that supplied them increasingly looked more and more similar to the larger industrial farming operations that early activists derided. Rather than creating a new, alternative system, the popularity of organic food instead began to replicate (or at least resemble) the same system it sought to replace. As an example of the types of paradoxes explored by Guthman, smaller farms that commit sales to local vendors often incur higher costs while receiving lower prices (Lohr & Park 2009).

The second form of analysis looks at smaller-scale producers and their evolution over time as the organic market grew. All producers faced many challenges in creating a viable organic market, as they negotiated the pursuit of ideological principles with the realities of agricultural practice. Olivia Saucier et al. (2016) conducted an in-depth study of organic dairy farmers in Vermont as the market for their products grew during the 1990s. Although the ever-increasing demand for organic dairy provided these smaller farmers with opportunities to grow and profit, the researchers also argue that these farmers had an opportunity to shape the development of this sector in terms of distribution and marketing.

Issues of producers also bring attention to the laborers who often toil in the fields under challenging work conditions. The agricultural labor market has long been fraught with exploitation and low wages; this is not an artifact of the past, and it is not limited to conventional industrial farming operations. Organic farming typically has higher labor costs, making the retention of workers even more critical (Lohr & Park 2009). Margaret Gray (2014a), author of *Labor and the Locavore*, has also raised this issue in an article titled “Food Ethics and Farm Labor: Local Organic Food Not as Pure as Advertised?” She finds that many of the labor conditions on organic farms—including smaller operations—resemble those of conventional farming.

Although issues of race and class shall be discussed in more detail below, they also arise with a bifurcation within the arena of organic production. Researchers have identified two primary types of smaller organic producers. The first includes farming families that have tended the land for generations, more recently entering the organic market for a variety of economic, political, and cultural reasons—the same range of motivations that influence actors at every level in this market.

These longer-term family farmers are juxtaposed with the second type of smaller organic producers, more recent entrants to organic farming, who often have no background in farming but, like so many of the 1970s countercultural participants in “back to the land” movements, have abandoned their previous careers and moved to more rural areas to engage in a project that promises more fulfillment. These operations often make more direct connections to others (often younger

Fair trade: not restricted to issues of food provisioning, fair trade involves deliberate attempts to promote the economic sustainability of lower-income producers in international trade

Alternative agriculture: production methods generally opposed to mainstream industrial farming techniques, focusing on preservation of water, soil, and other environmental resources

college students) who would like to gain some experience by volunteering or interning in the fields. Julie Guthman (2017, p. 19) reflects on their experiences in an article titled “Willing (White) Workers on Organic Farms? Reflections on Volunteer Farm Labor and the Politics of Precarity,” concluding that

As for the privileged precariat of educated, middle-class (white) young adults, only time will tell if their precarity and their purposeful blending of work and leisure will continue to be a choice or if their various state and familial safety nets will fall away. One thing seems clear, though: their voluntary presence on farms does little to bring about biopolitical recognition for traditional farmworkers, other than remind employers that paid employees are more reliable and better trained. So the young adults who today volunteer on farms and engage in other acts of self-provisioning may indeed be engaged in a politics of work reconfiguration, but theirs is not a politics of solidarity.

Although the bulk of this article reviews activities related to production, regulation, retailing, and consumption of organic food, this is certainly not the only institutional response to consumer interest in sustainable food systems. Explicitly administered primarily by private and transnational organizations—rather than by the state—fair-trade governance structures intentionally seek to address the common disparity of expressed ideals of equity with actual practices of exclusion found in democratic bureaucracies (Sen & Majumder 2011). Proponents of fair trade seek to address economic sustainability in many markets. Notably, these usually involve international transactions of goods originating in developing countries and consumed in wealthier ones, seeking to ensure equity for low-income workers. Although fair-trade labels might be most readily recognized in grocery aisles, fair-trade advocates are also concerned about craft products and textiles. Fair trade has emerged as another label signaling conscious ethical considerations, and (like organic food) it is subject to co-optation by the very companies it seeks to reform (Jaffee 2010).

Although consumer interest in sustainable food systems gradually increased during the 1940s and 1950s, widespread availability of food products grown in concordance with these ideals (particularly organic) did not take place until the 1970s. In the 1960s, a new wave of consumer cooperatives began to appear in response to the needs of a new constituency. Composed primarily of young people associated with the counterculture, interested in ecology and nutrition, and with few ties to the established consumer mainstream, consumer cooperatives supporting liberal or progressive political agendas concerned with participatory democracy, consumer health, and environmental protection arose.

Even though very few of these co-ops solely stocked organic foods—sourcing often involved convincing local farmers to try growing things in accordance with these principles—most were certainly in sympathy with the goals of alternative agriculture. Distribution networks were being created from scratch, but even at this small scale, compromises had to be made as these organizations attempted to satisfy a member’s (customer’s) desires while pursuing their longer-term aims of creating an alternative food system. As Michael Haedicke (2017, p. 134) has suggested in his cogent analysis of how the organic food industry took shape,

The co-op experience is one that involves the management of ambivalence in an effort to create compromises between market growth and systemic change. These compromises appear in hybrid organizational arrangements within and between co-op stores, and they reflect negotiations about the identity and purpose of co-ops as much as they do strategic thinking about the stores’ economic position in a changing market.

Co-ops were helped to negotiate and navigate the uncertainty inherent within the emerging organic food market.

Whole Foods, founded in 1978 and currently owned by Amazon’s Jeff Bezos, took the retailing of organic food into its next major phase. As it expanded into a national chain, it became the de

facto face of corporate organic retailing, providing a model for other organizations that sought to capitalize on increasing demand while creating an ecofriendly identity. It is generally credited with the mainstreaming of organic foods in the American market (for a more detailed examination of how the US organic market developed between the 1980s and 2010, see Youngberg & DeMuth 2013).

CONSUMERS AS ACTIVISTS?

The consumers of organic food, as well as the activists promoting sustainable food systems, are certainly not a monolith. Although as a subset of the population they might exhibit tendencies that deviate from the whole, they do not necessarily share common political, social, cultural, or religious values. Throughout the twentieth century, separate movements opposed to conventional agriculture for a variety of reasons eventually found common ground by promoting alternative food systems that could address ecological, economic, personal, and/or religious concerns. Similarly, today's collection of consumers might take several different paths that lead to making the same purchasing decision. That diversity of demographics and motivations has resulted in long-standing, unresolved tensions.

As organic food became mainstream—as the typical shopper was no longer a co-op member engaged in an economic transaction locally rooted in participatory democracy—it has become much more problematic to universally consider the consumers of these products as social movement actors. In many ways, this represents a successful outcome for these earlier activists. If changing cultural preferences to promote ethical consumerism had been the goal, then all these consumers were certainly contributing (consciously or not) to a project supporting a reform of the larger agricultural system. It is this lack of coordinated collective behavior, however, that has prompted some of the most interesting analysis of this still-growing market sector.

Josée Johnston (2008) provides perhaps the best articulation of the multiple (and often competing) factors influencing consumer motivations for purchasing organic foods in her article “The Citizen-Consumer Hybrid: Ideological Tensions and the Case of Whole Foods Market.” The focus on the “citizen-consumer” concept, one that simultaneously contains an “and/or” within its hyphen, characterizes two primary features of the contemporary organic market. First, shoppers are encouraged to embrace an identity as an ethical consumer, one who is making a positive social change with every transaction. They are given a sense of agency, even if they do not have to take any further actions once they have moved beyond the cash register to take their groceries home and move on with their lives. Second, the market player (whether it be Whole Foods or not) is able to promote itself as a facilitator or even as an advocate for social change as well, despite its ability to undermine those goals through a myriad of unrelated corporate actions.

Organic consumers are not a random subset of the general population. Jessica Paddock (2016) explores class issues associated with participation in alternative food systems. Many of the middle-class participants she interviewed saw their consuming choices as a marker of their status, creating distinctions from (rather than solidarity with) working-class individuals who might have similar preferences. Such sentiments reflect long-standing tensions within sustainable food movements, questioning whether higher-priced organic food products (Lin et al. 2008) are inherently destined as boutique products lending themselves to familiar elite patterns of conspicuous consumption.

One enduring critique of organic and other sustainable food systems has been the extent to which they reinforce existing inequalities instead of addressing them. These issues were present and explicitly discussed even in the 1970s, as activists explicitly questioned whether organic foods would primarily benefit elite consumers (given the higher market value associated with these products) at the expense of those who were already struggling to obtain healthy, nutritional food

Alternative foods:

specific products
produced by
alternative agriculture
and provisioned
through alternative
food systems

products (Cox 1994, Upright 2020). Organic food is easily characterized as an option privileged by upper-class White consumers (Sublette & Martin 2013), along with locavore diets associated with whole foods. Ryanne Pilgeram (2012, p. 53) also observes at a Pacific Northwest farmer's market that "sustainable agriculture is a space of whiteness."

THE STATE AND REGULATIONS

Government agencies primarily play two roles with regard to the production, marketing, and distribution of sustainable food products: promotion and regulation. The regulation of standards-based alternative foods usually relates to restricting the appellation of labels to products that will merit increased rents in the agricultural marketplace; these are enhancements that go above and beyond basic safety protocols that might appeal to select segments of the consumer market.

Perhaps the most highly developed set of regulations revolves around the organic label, as this is one of the oldest and best-known production regimes in the sustainability arena. This term, however, was highly contested from the inception of Rodale's magazines that included it in the title; although there might have been a common popular understanding that these agricultural practices avoided (or prohibited) "chemicals" such as pesticides and fertilizers, the more specific scientific or regulatory specifications were contested and debated between the 1950s and 1970s. This made certification regimes highly problematic, making it difficult for consumers to know what they were purchasing while less scrupulous producers were able to easily enter the market with little oversight. "Even had there been complete agreement as to the meaning of 'organic' foods, there would have remained the problem of verifying compliance with it, which J. I. Rodale's son Robert referred to as 'the organic certification problem'" (Nowacek & Nowacek 2008, p. 409).

In the United States, organic certification at the federal level was first prompted by the Organic Foods Production Act (OFPA) of 1990. This created a federal National Organics Program (NOP) administered by the US Department of Agriculture's Agricultural Marketing Service (USDA AMS). The creation of a single national standard was intended to supersede the myriad state-level regulations that had been created in the previous 15 years (states were allowed to create additional requirements, subject to approval from the USDA AMS, but to date none have done so). The OFPA and the NOP created a 15-member National Organic Standards Board. After many years of contentious negotiations, the final rule was adopted in 2000.

Patricia Allen & Martin Kovach (2000) provided an analysis of the activities leading up to the adoption of the National Organic Standards Act, pointing out some of the inherent contradictions involved in regulating a production regime originally based on ideological concerns that would primarily benefit for-profit capitalist organizations; this tension has continued to this day. Even after the first national organic standards were proposed in 1997, then Secretary of Agriculture Dan Glickman stated explicitly that this was merely a marketing term that did not imply any health or environmental benefits. As Allen & Kovach (2000, p. 224) wrote, "Many of the contradictions arise because of the nature of standards, which inevitably cannot perfectly capture the ideal they are meant to represent."

Sustainable farming/consumption practices also raise issues about local control of food systems. Gill Seyfang (2007, p. 119) explored this issue in the article "Cultivating Carrots and Community: Local Organic Food and Sustainable Consumption," finding that "local organic food [represents] a wide range of competing objectives and values for consumers, which have been categorised into three paradigms: as a tool for creating green localised economies, as health-conscious global food for supermarket shoppers, and as reactionary fare for status-driven traditionalists." A more macrolevel analysis can be found in Teresa Marie Mares & Alison Hope Alkon's (2011) article "Mapping the Food Movement: Addressing Inequality and Neoliberalism." They find that much of the scholarship to date has been "rightly critical of the US food movement

for adopting market-driven strategies that envision individual, ‘ethical’ consumers and producers as the locus of social change” (Mares & Alkon 2011, p. 81). Hannah Wittman (2011), continuing the analysis of social movement framing, finds that many contemporary movements focus on “food sovereignty” as a primary focus of their work. Defined in the 2007 Nyéléni Forum for Food Sovereignty as “The right of peoples to healthy and culturally appropriate food produced through ecologically sound and sustainable methods, and their right to define their own food and agriculture systems” (quoted in Wittman 2011, p. 88), the concept of food sovereignty refers to the economic, political, and social arrangements that often disadvantage those who are not in positions of power to control their local food systems.

GLOBALIZATION

Finally, researchers have explored how the entire market for sustainable foods crosses national borders, as agriculture has long been a global market. They have examined consumer motivations across the globe. Urban et al. (2012) ask “What Motivates Czech Consumers to Buy Organic Food?” Darrell Gene Moen (2000) explores “Grassroots-Based Organic Foods Distributors, Retailers, and Consumer Cooperatives in Japan: Broadening the Organic Farming Movement.” Ligita Melece (2005) provides a background of EU organic regulations and their application in Latvia.

Several researchers have documented similar consumer-driven issues; although cultural diffusion certainly plays a role, status inequalities often play out in similar ways across a wide range of different countries. Joy Zhang, for example, describes how the Chinese government’s project of “food modernization” (characterized by large-scale, consolidated production of essential staples) is very different from the middle-class citizenry. She (Zhang 2018, p. 151) refers to this as the “Good Food Movement:”

For they all subscribe to the pursuance of “liang-shi, liang-ren, liang-xin”, literally translated as “good food, good people and good heart.” Similar to other western consumer-based alternative food initiatives (DeLind 2011, Levkoe 2014, Nonini 2013, Starr 2010), this Movement puts more emphasis on empowering individuals and on environmentally conscious development that is sensitive to specific contexts. They thus take a more critical and reflexive view on questions such as how technologies should be applied and on what urban consumers can contribute to a sustainable food system.

Rafi Groszlik (2021) titled his work *Globalizing Organic*, using the more recent development of the organic food industry in Israel as his starting point. Continuing his research into the “citizen-consumer” framework, he finds not only that the increasing global status of organic food has an impact on the producers’ (and the states’) interest in participating in this market but that organic consumption is often a status marker among consumers as well.

Global inequalities have been explored in several ways, but over the past two decades a framework of Global South versus Global North, often interpreted as developing versus developed countries, has become an important part of the discourse. These types of studies also explore specific populations outside of the United States that attempt to address equity issues for producers, often smaller market players subject to exploitation. One example is Beatriz Cid Aguayo & Alex Latta’s (2015) “Agro-Ecology and Food Sovereignty Movements in Chile: Sociospatial Practices for Alternative Peasant Futures.” Echoing a common theme of larger market players reaping international trade benefits at the expense of smaller groups of indigenous producers and laborers, Aguayo & Latta provide just one of many examples of how the creation of local networks facilitates the sharing of information and increases (although sometimes only marginally) collective power.

One reason that the US federal government adopted a single national standard for organic food was to facilitate international trade. European trading partners were much more willing to

recognize and accept a common and consistent set of practices. This is itself, however, an indication of how the organic sector (and especially its certification regimes) has become an important component of international trade, one that is much more conducive to larger agribusiness players (Barrett et al. 2002, Harris 2008, Oberholtzer et al. 2013).

Laura Reynolds (2004) provided one of the first major examinations of the global market for sustainable foods, using a north–south framework that has been followed in later studies. Exploring the institutionalization and regulation of global organic trade, she was prescient in anticipating that increasing standardization would further commodify organic food in a way that increases rather than addresses existing inequities (Reynolds 2004, p. 738):

In short, certification represents a powerful new form of network governance which is rooted in social, legal, and bureaucratic institutions, yet serves in many ways to accentuate traditional economic inequalities between firms and countries. Onerous and expensive organic certification requirements create significant barriers to entry for poor Southern producers and encourage the concentration of organic production and price premiums in the hands of large corporate producers.

Global certification regimes have developed through a process of institutional isomorphism (DiMaggio & Powell 1983), as nation-states gradually adopt regulatory and labeling schemes that mimic those of more-powerful trading partners. Shaila Seshia Galvin (2011) provided a fairly comprehensive overview of activities related to this area in “Nature’s Market? A Review of Organic Certification.” Galvin (2011, p. 49) documents the research on certification regimes to consider “how organic certification has been understood as a social, political, and cultural process.” Despite a variety of certification regimes and bifurcated markets, the impacts are often similar for producers in the Global South (especially the smaller market players) as they attempt to gain a foothold in this growing international trade that, at least for them, is largely export-oriented.

CONCLUSION

During the 1960s, at the dawning of the Age of Aquarius, countercultural activists challenged many mainstream institutions and promoted greater self-awareness regarding how individual actions could have an impact on larger social structures. During the 1970s, a variety of different projects sought to create new organizations and programs to institutionalize these beliefs. As many of these groups and movements celebrate the 50th-anniversary celebrations of their foundings, it is entirely appropriate to reflect on the longer-lasting impact of these movements. Public awareness and attitudes toward organic food in particular have undergone a remarkable transformation: once derided by the US Secretary of Agriculture, the federal organic label can be found somewhere in nearly every grocery store, corner store, and truck stop throughout America.

In every case when the goals of a smaller, oppositional movement become part of the mainstream culture, there will be many complaints that the purity of the original has been lost in translation as it ramped up in scale to cater to a wider audience. Given the multiplicity of social actor critiques and aims as described above, it seems entirely relevant to ask if the mainstreaming of ethical consumerism has helped to foster more sustainable food systems.

Lucy Atkinson (2012) finds such evidence for the creation of engaged citizenry in a study of self-identified socially conscious consumers. They not only found personal benefits through their purchasing choices but also embraced larger civic collective-good virtues such as a cleaner environment and workers’ rights. Such studies are limited, however, in that (*a*) it is difficult to establish causation, i.e., whether these ideological orientations predisposed their participation in ethical consumerism, and (*b*) attitudes do not always translate into action.

It is much more common to find researchers questioning the limits and potential for a social movement that relies so heavily on individual choice in the absence of more explicit collective

behavior. It is easy to fault the rise of an organic food market for not addressing a host of issues that remain unresolved. “Attention Whole Foods Shoppers,” declares an article by Richard Paarlberg (2010). “Stop obsessing about arugula. Your ‘sustainable’ mantra—organic, local, and slow—is no recipe for saving the world’s hungry millions” (Paarlberg 2010, p. 80). Although organic activists never claimed that this was the recipe (Lappé & Locke 2010), Paarlberg correctly points out that there are many issues of food access, equity, and sovereignty to be resolved (interestingly, proponents of the Green Revolution actually did make such claims, repeatedly; the failure of this widely adopted technological innovation makes one question the true aims of those who profited the most from these regimes).

It must be said that many of the current critiques of organic food as a “solution” to address existing inequalities, enduring ecological issues, or capitalist domination of food markets at every level were certainly anticipated long ago. Laura B. DeLind (2000, p. 199), for example, wrote back in 2000 (just as the national organic standards were being passed) about an “inherent irony”:

As organic food and farming are increasingly integrated into national-level agricultural policy, they are increasingly threatened by the disintegration of the very principles upon which they depend. More specifically, it questions the degree to which organic farming and food production can become involved in, or otherwise mimic, a singularly market-dominated and profit-driven agriculture and be true to their essential nature.

Although increasing consumer demand for food products created within a sustainable agricultural framework has undoubtedly been rising throughout the world, Cindy Isenhour (2011) questions whether this force is enough to achieve larger goals of systemic change. Asking “Can Consumer Demand Deliver Sustainable Food?,” she surveyed existing research and remained skeptical (Isenhour 2011, pp. 20–21):

Consumers are confronted with barriers that prevent achievement of more significant change. Individuals can buy organic foods at the local farmers markets, reduce meat consumption, and boycott foods produced with palm oil. But as Wright and Middendorf (2008) argue, mindful eating cannot dismantle historically embedded social structures. The achievement of wider structural changes requires collective action (Brunori et al. 2008) and a ‘renewed ideological debate on private versus public responsibilities’ (Jacobsen and Dulsrud 2007, p. 479).

Colleen Derkatch & Philippa Spoel (2017) echo this concern in an evaluation of public health messages originating from local government agencies in Ontario, Canada, that promote the consumption of local foods. Although it is difficult to argue with either the motivation or the aims of such groups, the researchers suggest that even successful campaigns are unlikely to have a larger macro impact. “Although public health promotion of local food aims to improve health, our analysis shows that it simultaneously serves as a vector for the advancement of a neo-liberal ideology in which ‘good’ health citizenship is facilitated principally through personal behavior and informed consumer choice, not through policy or regulatory mechanisms” (Derkatch & Spoel 2017, pp. 164–65).

In many ways, the development of the current organic market points out the need for even more social movement activity to effect longer-lasting institutional change. The creation of meaningful state regulations governing the labeling of food products that cater to consumer ethical values has proved to be an arduous task in many circumstances. Industry actors have enormous clout with politicians, and they desire a set of standards that they can readily achieve to take advantage of the higher costs associated with such products. As suggested above, the creation of the US federal standards was a 12-year process, and activists had to repeatedly counter attempts by producers to water them down. Christine Parker (2013, p. 54) describes a similar process in Australia in “Voting with Your Fork? Industrial Free-Range Eggs and the Regulatory Construction of Consumer Choice.”

Local foods: a relative term emphasizing consumption of products close to their point of origin, often associated with lower carbon footprints and local economic foodsheds

This article argues [that] consumers cannot bring an alternative product into existence through the power of choice alone: the choices available to consumers have already been constructed and constrained by relationships between actors in the production, distribution, and exchange chain who bring products to retail.

To be fair, it was only the wildly optimistic (or perhaps naïve) activist who imagined that ethical consumerism could in and of itself create an alternative, sustainable agricultural food system. Changing personal preferences was always a necessary but insufficient step toward this goal.

However, we live in a moment of renewed social movement activity, and activists and organizations have renewed commitments (and gathered new recruits) to address long-standing issues in many arenas of social life. A more recent volume edited by Alison Alkon & Julie Guthman (2017) titled *New Food Activism: Opposition, Cooperation, and Collective Action* contains several explorations of current activities seeking to reconcile issues of access, equity, and sustainability—written in large part by the next generation of scholars who will both promote and document these activities in the years to come.

DISCLOSURE STATEMENT

The author is not aware of any affiliations, memberships, funding, or financial holdings that might be perceived as affecting the objectivity of this review.

ACKNOWLEDGMENTS

The author thanks the editors and reviewers of the *Annual Review of Food Science and Technology* for the opportunity to provide this review and their invaluable feedback, especially Mary Ann Lila and Absolom J. Hagg. The author is indebted to the previous scholars who provided excellent summaries of work in this area, including Philip Conford, Rafi Groszlik, Julie Guthman, and Josée Johnston. Research in this project was supported by Miguel Centeno, Paul DiMaggio, Ruthann Godollei, and Robert Wuthnow. All errors (including those of omission) are the sole responsibility of the author.

LITERATURE CITED

- Adams M. 2018. The aesthetic value of local food. *Monist* 101:324–39
- Aguayo BC, Latta A. 2015. Agro-ecology and food sovereignty movements in Chile: sociospatial practices for alternative peasant futures. *Ann. Assoc. Am. Geogr.* 105:397–406
- Alkon A, Guthman J, eds. 2017. *New Food Activism: Opposition, Cooperation, and Collective Action*. Berkeley: Univ. Calif. Press
- Allen P, Kovach M. 2000. The capitalist composition of organic: the potential of markets in fulfilling the promise of organic agriculture. *Agric. Hum. Values* 17:221–32
- Alrøe H, Møller H, Læssøe J, Noe E, eds. 2016. *Ecology and Society: Special Issue: Multicriteria Assessment of Food System Sustainability*. Dedham, MA: Resilience Alliance
- Atkinson L. 2012. Buying in to social change: how private consumption choices engender concern for the collective. *Ann. Am. Acad. Political Soc. Sci.* 644:191–206
- Barrett HR, Browne AW, Harris PJC, Cadoret K. 2002. Organic certification and the UK market: organic imports from developing countries. *Food Policy* 27:301–18
- Barton GA. 2018. *The Global History of Organic Farming*. Oxford, UK: Oxford Univ. Press
- Brown C, Miller S. 2008. The impacts of local markets: a review of research on farmers markets and community supported agriculture (CSA). *Am. J. Agric. Econ.* 90:1296–302
- Browne AW, Harris PJC, Hofny-Collins AH, Pasiecznik N, Wallace RR. 2000. Organic production and ethical trade: definition, practice and links. *Food Policy* 25:69–89
- Brunori G, Guidi F, Rossi A. 2008. *On the new social relations around and beyond food: analysing consumers role and action*. Paper presented at the Sustainable Consumption Conference, Arlon, Belgium

- Buck D, Getz C, Guthman J. 1997. From farm to table: the organic vegetable commodity chain of northern California. *Sociol. Rural.* 37:3–20
- Carson R. 1962. *Silent Spring*. Boston: Houghton Mifflin
- Cone CA, Myhre A. 2000. Community-supported agriculture: a sustainable alternative to industrial agriculture? *Hum. Organ.* 59:187–97
- Conford P. 2001. *The Origins of the Organic Movement*. Edinburgh, Scotl.: Floris
- Cox C. 1994. *Storefront Revolution: Food Co-Ops and the Counterculture*. New Brunswick, NJ: Rutgers Univ. Press
- DeLind LB. 2000. Transforming organic agriculture into industrial organic products: reconsidering national organic standards. *Hum. Organ.* 59:198–208
- DeLind LB. 2011. Are local food and the local food movement taking us where we want to go? Or are we hitching our wagons to the wrong stars? *Agric. Hum. Values* 28:273–83
- Derkatch C, Spoel P. 2017. Public health promotion of “local food”: constituting the self-governing citizen-consumer. *Health* 21:154–70
- DiMaggio PJ, Powell WW. 1983. The iron cage revisited: institutional isomorphism and collective rationality in organizational fields. *Am. Sociol. Rev.* 48(2):147–60
- Fitzgerald DK. 2003. *Every Farm a Factory: The Industrial Ideal in American Agriculture*. New Haven, CT: Yale Univ. Press
- Fromartz S. 2006. *Organic, Inc.: Natural Foods and How They Grew*. Orlando, FL: Harcourt
- Galvin SS. 2011. Nature’s market? A review of organic certification. *Environ. Soc.* 2:48–67
- Goodman D, DuPuis EM, Goodman MK. 2014. *Alternative Food Networks: Knowledge, Practice and Politics*. London: Routledge
- Goodman D, Redclift M. 1991. The origins of the modern agri-food system. In *Refashioning Nature: Food, Ecology and Culture*, ed. D Goodman, M Redclift, pp. 87–132. London: Routledge
- Goodman D, Watts M. 1997. *Globalising Food: Agrarian Questions and Global Restructuring*. London: Routledge
- Gore A. 2006. *An Inconvenient Truth: The Planetary Emergency of Global Warming and What We Can Do About It*. New York: Rodale Press
- Graham FJ. 1970. *Since Silent Spring*. Boston: Houghton Mifflin
- Gray M. 2014a. Food ethics and farm labor: local organic food not as pure as advertised? *Perspect. Work* 18:14–17
- Gray M. 2014b. *Labor and the Locavore: The Making of a Comprehensive Food Ethic*. Berkeley: Univ. Calif. Press
- Groszlik R. 2021. *Globalizing Organic: Nationalism, Neoliberalism, and Alternative Food in Israel*. Albany, NY: SUNY Press
- Guthman J. 2004. *Agrarian Dreams: The Paradox of Organic Farming in California*. Berkeley: Univ. Calif. Press
- Guthman J. 2017. Willing (white) workers on organic farms? Reflections on volunteer farm labor and the politics of precarity. *Gastronomica* 17:15–19
- Haedicke MA. 2017. *Organizing Organic: Conflict and Compromise in an Emerging Market*. Stanford, CA: Stanford Univ. Press
- Harris P. 2008. Certification and trade issues in organic agriculture. In *Organic Agriculture and Millennium Development Goals*, ed. IOO Aiyelaagbe, MT Adetunji, SA Osei, pp. 18–25. Bonn, Ger.: IFOAM
- Haydu J. 2011. Cultural modeling in two eras of U.S. food protest: Grahamites (1830s) and organic advocates (1960s–70s). *Soc. Probl.* 58:461–87
- Holcomb RB, Neill CL, Lelekacs J, Velandia M, Woods TA, et al. 2018. A local food system glossary: a rose by any other name. *Choices* 33:1–8
- Hooker N, Simons CT, Parasidis E. 2018. “Natural” food claims: industry practices, consumer expectations, and class action lawsuits. *Food Drug Law J.* 73:319–37
- Howard SA. 1940. *An Agricultural Testament*. London: Oxford Univ. Press
- Isenhour C. 2011. Can consumer demand deliver sustainable food? Recent research in sustainable consumption policy and practice. *Environ. Soc.* 2:5–28
- Jacobsen E, Dulsrud A. 2007. Will consumers save the world? The framing of political consumerism. *J. Agric. Environ. Ethics* 20:469–82
- Jaffee D. 2010. Fair trade standards, corporate participation, and social movement responses in the United States. *J. Bus. Ethics* 92:267–85

- Johnston J. 2008. The citizen-consumer hybrid: ideological tensions and the case of Whole Foods Market. *Theory Soc.* 37:229–70
- Lappé A, Locke J. 2010. Food fight. *Foreign Policy* 180:13–15
- Levkoe CZ. 2014. The food movement in Canada: a social movement network perspective. *J. Peasant Stud.* 41:385–403
- Lin B-H, Smith TA, Huang CL. 2008. Organic premiums of US fresh produce. *Renew. Agric. Food Syst.* 23:208–16
- Lohr L, Park TA. 2009. Labor pains: valuing seasonal versus year-round labor on organic farms. *J. Agric. Resour. Econ.* 34:316–31
- Mares TM, Alkon AH. 2011. Mapping the food movement: addressing inequality and neoliberalism. *Environ. Soc.* 2:68–86
- Melece L. 2005. Issues regarding origin labeling of food in Latvia. *Soc. Econ.* 27:317–26
- Moen DG. 2000. Grassroots-based organic foods distributors, retailers, and consumer cooperatives in Japan: broadening the organic farming movement. *Hitotsubashi J. Soc. Stud.* 32:55–76
- Nabhan GP. 2009. *Coming Home to Eat: The Pleasures and Politics of Local Foods*. New York: Norton
- Nonini DM. 2013. The local-food movement and the anthropology of global systems. *Am. Ethnol.* 40:267–75
- Nowacek DM, Nowacek RS. 2008. The organic foods system: its discursive achievements and prospects. *Coll. Engl.* 70:403–20
- Oberholtzer L, Dimitri C, Jaenicke EC. 2013. International trade of organic food: evidence of US imports. *Renew. Agric. Food Syst.* 28:255–62
- Paarlberg R. 2010. Attention Whole Foods shoppers. *Foreign Policy*, April 26. <https://foreignpolicy.com/2010/04/26/attention-whole-foods-shoppers/>
- Paddock J. 2016. Positioning food cultures: ‘alternative’ food as distinctive consumer practice. *Sociology* 50:1039–55
- Parker C. 2013. Voting with your fork? Industrial free-range eggs and the regulatory construction of consumer choice. *Ann. Am. Acad. Political Soc. Sci.* 649:52–73
- Peters CJ, Bills NL, Wilkins JL, Fick GW. 2009. Foodshed analysis and its relevance to sustainability. *Renew. Agric. Food Syst.* 24:1–7
- Pietrykowski B. 2004. You are what you eat: the social economy of the slow food movement. *Rev. Soc. Econ.* 62:307–21
- Pilgeram R. 2012. Social sustainability and the white, nuclear family: constructions of gender, race, and class at a northwest farmers’ market. *Race Gender Class* 19:37–60
- Plumecocq G, Debril T, Duru M, Magrini M-B, Sarthou JP, Therond O. 2018. The plurality of values in sustainable agriculture models: diverse lock-in and coevolution patterns. *Ecol. Soc.* 23(1):21
- Pollan M. 2006. *The Omnivore’s Dilemma: A Natural History of Four Meals*. New York: Penguin Press
- Raynolds LT. 2004. The globalization of organic agro-food networks. *World Dev.* 32:725–43
- Rodale JI. 1967. Why I started organic gardening. In *Organic Gardening & Farming*, pp. 30–34. Emmaus, PA: Rodale Press
- Rudd RL. 1964. *Pesticides and the Living Landscape*. Madison: Univ. Wis. Press
- Saucier OR, Parsons RL, Inwood S. 2016. Redefining the farmer-processor relationship: the story of Organic Cow. *Enterp. Soc.* 17:358–92
- Sen D, Majumder S. 2011. Fair trade and fair trade certification of food and agricultural commodities: promises, pitfalls, and possibilities. *Environ. Soc.* 2:29–47
- Seyfang G. 2007. Cultivating carrots and community: local organic food and sustainable consumption. *Environ. Values* 16:105–23
- Shindelar R. 2015. The ecological sustainability of local food systems. *RCC Perspect.* 1:19–24
- Starr A. 2010. Local food: a social movement? *Cult. Stud. Crit. Methodol.* 10:479–90
- Steiner R. 1993. *Spiritual Foundations for the Renewal of Agriculture*. Kimberton, PA: Bio-Dyn. Farming Gard. Assoc.
- Sublette CM, Martin J. 2013. Let them eat cake, caviar, organic, and whole foods: American elitism, white trash dinner parties, and diet. *Stud. Pop. Cult.* 36:21–44
- Upright CB. 2020. *Grocery Activism: The Radical History of Food Cooperatives in Minnesota*. Minneapolis: Univ. Minn. Press

- Urban J, Zvěřinová I, Ščasný M. 2012. What motivates Czech consumers to buy organic food? *Czech Sociol. Rev.* 48:509–36
- van den Bosch R. 1978. *The Pesticide Conspiracy*. Garden City, NY: Doubleday
- Wilk RR. 2006. *Fast Food/Slow Food: The Cultural Economy of the Global Food System*. Lanham, MD: Altamira Press
- Wittman H. 2011. Food sovereignty: a new rights framework for food and nature? *Environ. Soc.* 2:87–105
- Wright W, Middendorf G. 2008. Introduction: fighting over food—change in the agri-food system. In *The Fight Over Food: Producers, Consumers, and Activists Challenge the Global Food System*, ed. W Wright, G Middendorf, pp. 1–26. University Park, PA: Penn. State Univ. Press
- Youngberg G, DeMuth SP. 2013. Organic agriculture in the United States: a 30-year retrospective. *Renew. Agric. Food Syst.* 28:294–328
- Zhang JY. 2018. How to be modern? The social negotiation of ‘good food’ in contemporary China. *Sociology* 52:150–65



Contents

| | |
|---|-----|
| A Comprehensive Review of Nanoparticles for Oral Delivery in Food: Biological Fate, Evaluation Models, and Gut Microbiota Influences <i>Jingyi Xue, Christopher Blesso, and Yangchao Luo</i> | 1 |
| Novel Colloidal Food Ingredients: Protein Complexes and Conjugates <i>Fuguo Liu, David Julian McClements, Cuicui Ma, and Xuebo Liu</i> | 35 |
| Targeting Interfacial Location of Phenolic Antioxidants in Emulsions: Strategies and Benefits <i>Claire Berton-Carabin and Pierre Villeneuve</i> | 63 |
| Molecular Changes of Meat Proteins During Processing and Their Impact on Quality and Nutritional Values <i>Chunbao Li, Anthony Pius Bassey, and Guanghong Zhou</i> | 85 |
| A Dual Function of Ferritin (Animal and Plant): Its Holo Form for Iron Supplementation and Apo Form for Delivery Systems <i>Xiaoxi Chang, Chenyan Lv, and Guanghua Zhao</i> | 113 |
| Applications of the INFOGEST In Vitro Digestion Model to Foods: A Review <i>Hualu Zhou, Yunbing Tan, and David Julian McClements</i> | 135 |
| Predicting Personalized Responses to Dietary Fiber Interventions: Opportunities for Modulation of the Gut Microbiome to Improve Health <i>Car Reen Kok, Devin Rose, and Robert Hutkins</i> | 157 |
| Metabolic Signatures from Genebank Collections: An Underexploited Resource for Human Health? <i>Nese Sreenivasulu, Saleh Alseikh, Rhowell N. Tiozon Jr., Andreas Graner, Cathie Martin, and Alisdair R. Fernie</i> | 183 |
| Bioinformatic Approaches for Characterizing Molecular Structure and Function of Food Proteins <i>Harrison Helmick, Anika Jain, Genki Terashi, Andrea Liceaga, Arun K. Bhunia, Daisuke Kihara, and Jozef L. Kokini</i> | 203 |

| | |
|---|-----|
| Biotechnology in Future Food Lipids: Opportunities and Challenges <i>Qingqing Xu, Qingyun Tang, Yang Xu, Junjun Wu, Xiangzhaobao Mao, Fuli Li, Shian Wang, and Yonghua Wang</i> | 225 |
| Engineering Nutritionally Improved Edible Plant Oils <i>Xue-Rong Zhou, Qing Liu, and Surinder Singh</i> | 247 |
| Enzymatic Approaches for Structuring Starch to Improve Functionality <i>Ming Miao and James N. BeMiller</i> | 271 |
| Nondigestible Functional Oligosaccharides: Enzymatic Production and Food Applications for Intestinal Health <i>Shaoqing Yang, Chenxuan Wu, Qiaojuan Yan, Xiuting Li, and Zhengqiang Jiang</i> | 297 |
| Diet-Derived Antioxidants: The Special Case of Ergothioneine <i>Barry Halliwell, Richard M.Y. Tang, and Irwin K. Cheah</i> | 323 |
| Indole-3-Carbinol: Occurrence, Health-Beneficial Properties, and Cellular/Molecular Mechanisms <i>Darshika Amarakoon, Wu-Joo Lee, Gillian Tamia, and Seong-Ho Lee</i> | 347 |
| Bacteriophages in the Dairy Industry: A Problem Solved? <i>Guillermo Ortiz Charneco, Paul P. de Waal, Irma M.H. van Rijswijk, Noël N.M.E. van Peij, Douwe van Sinderen, and Jennifer Mabony</i> | 367 |
| Bovine Colostrum for Veterinary and Human Health Applications: A Critical Review <i>Kevin Linehan, R. Paul Ross, and Catherine Stanton</i> | 387 |
| Addressing Consumer Desires for Sustainable Food Systems: Contentions and Compromises <i>Craig Upright</i> | 411 |
| Sensory Analysis and Consumer Preference: Best Practices <i>M.A. Drake, M. E. Watson, and Y. Liu</i> | 427 |
| Mechano-Bactericidal Surfaces: Mechanisms, Nanofabrication, and Prospects for Food Applications <i>Yifan Cheng, Xiaojing Ma, Trevor Franklin, Rong Yang, and Carmen I. Moraru</i> | 449 |
| Mild Fractionation for More Sustainable Food Ingredients <i>A. Lie-Piang, J. Yang, M.A.I. Schutyser, C.V. Nikiforidis, and R.M. Boom</i> | 473 |
| Microbubbles in Food Technology <i>Jiakai Lu, Owen G. Jones, Weixin Yan, and Carlos M. Corvalan</i> | 495 |
| How Can AI Help Improve Food Safety? <i>C. Qian, S.I. Murphy, R.H. Orsi, and M. Wiedmann</i> | 517 |

Microgreens for Home, Commercial, and Space Farming:
A Comprehensive Update of the Most Recent Developments
*Zi Teng, Yaguang Luo, Daniel J. Pearlstein, Raymond M. Wheeler,
Christina M. Johnson, Qin Wang, and Jorge M. Fonseca* 539

Errata

An online log of corrections to *Annual Review of Food Science and Technology* articles may be found at <http://www.annualreviews.org/errata/food>